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(54) **CHEMICAL/BIOLOGICAL HELMET**

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(52) **U.S. Cl.** **2/424**; 2/171.3; 128/201.25

(58) **Field of Search** ..... 2/422, 410, 436, 2/437, 424, 423, 171.3, 457, 205, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 906, DIG. 1; 128/201.24, 201.25, 201.23, 201.15, 200.28

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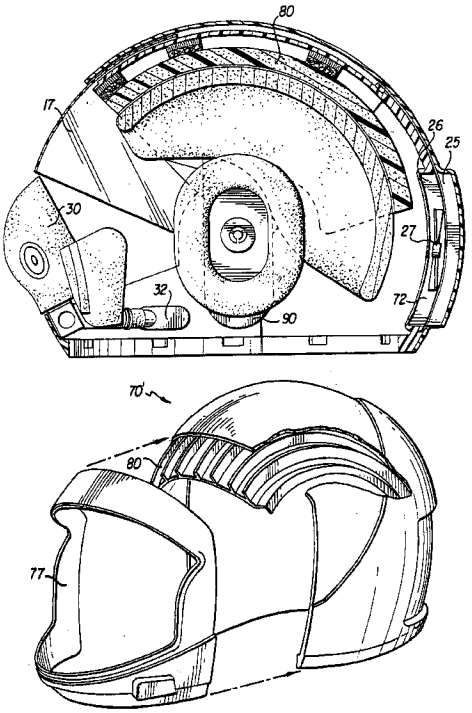
(57) **ABSTRACT**

A chemical/biological protection helmet is provided with a filter system. In order to provide for improved balance control and visibility, the filter system is positioned in the rear of the helmet. By rotating the visors, provided in the front of the helmet, the filter system can be actuated as the helmet is sealed.

16 Claims, 3 Drawing Sheets



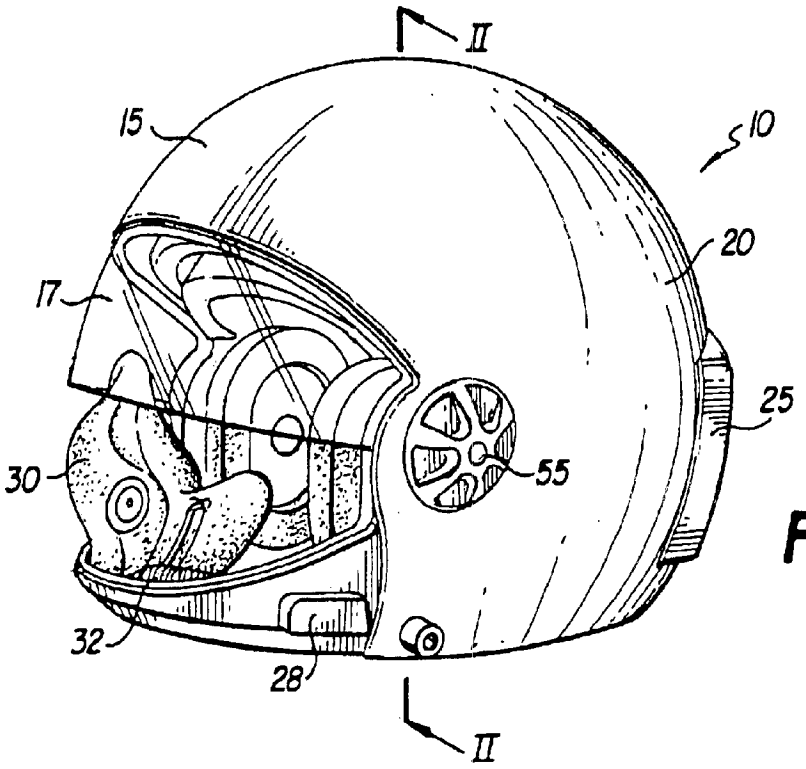


FIG. 1

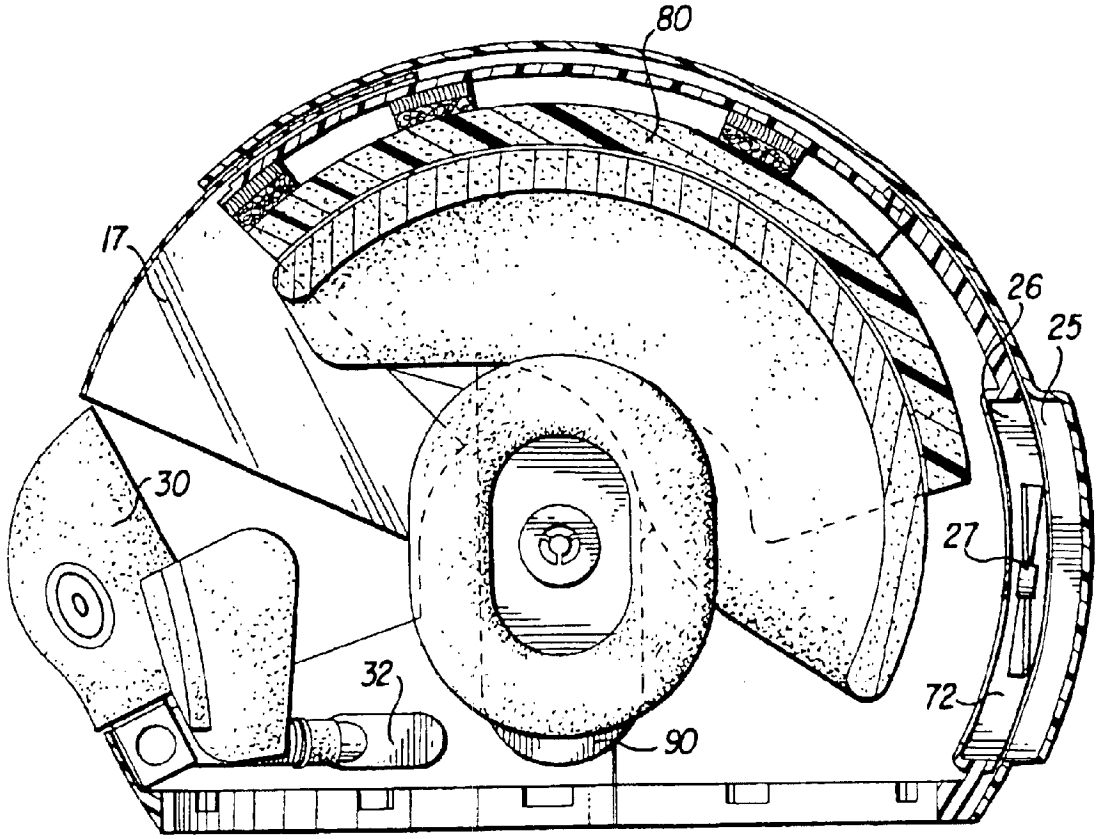


FIG. 2

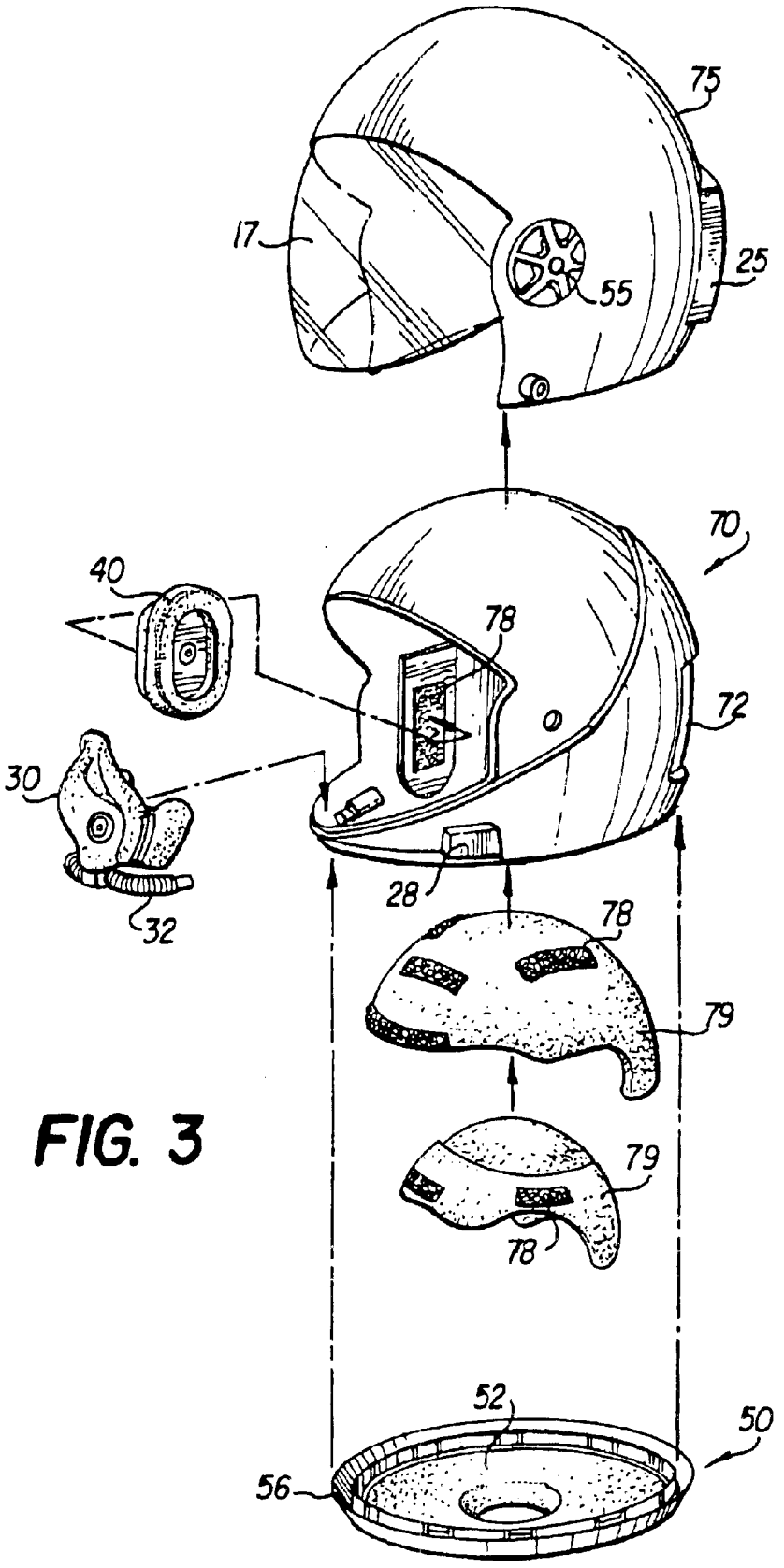


FIG. 3

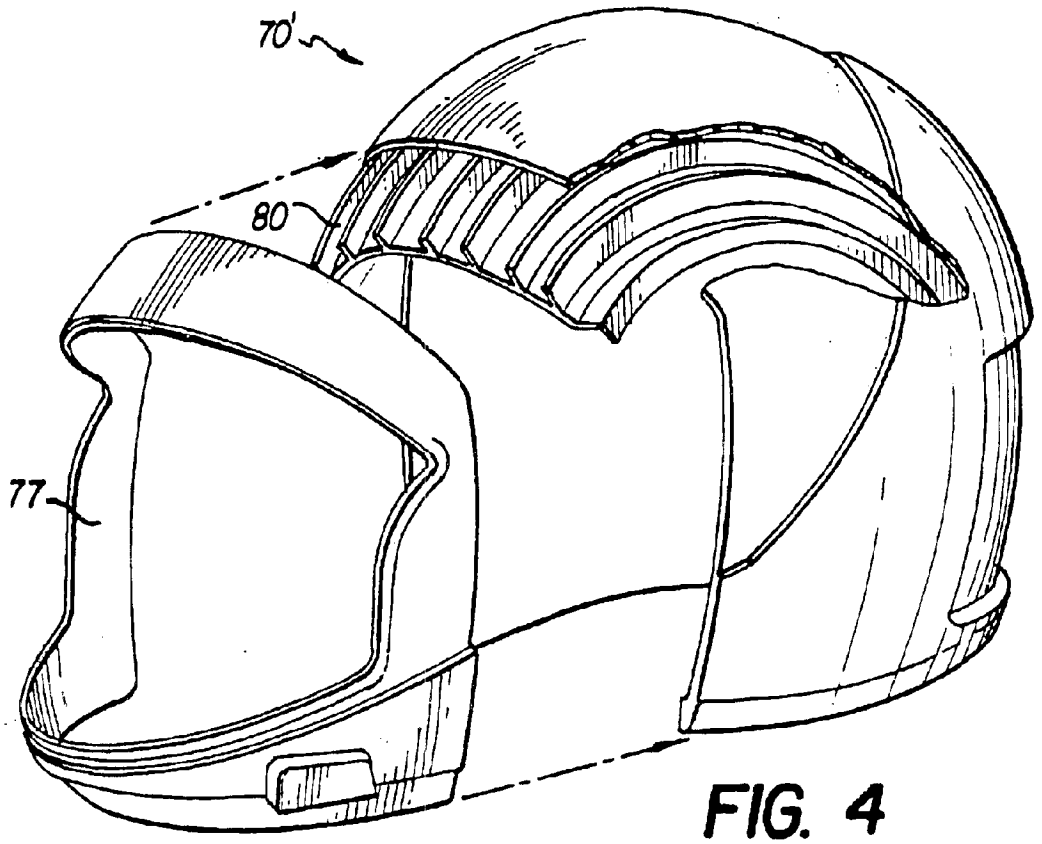
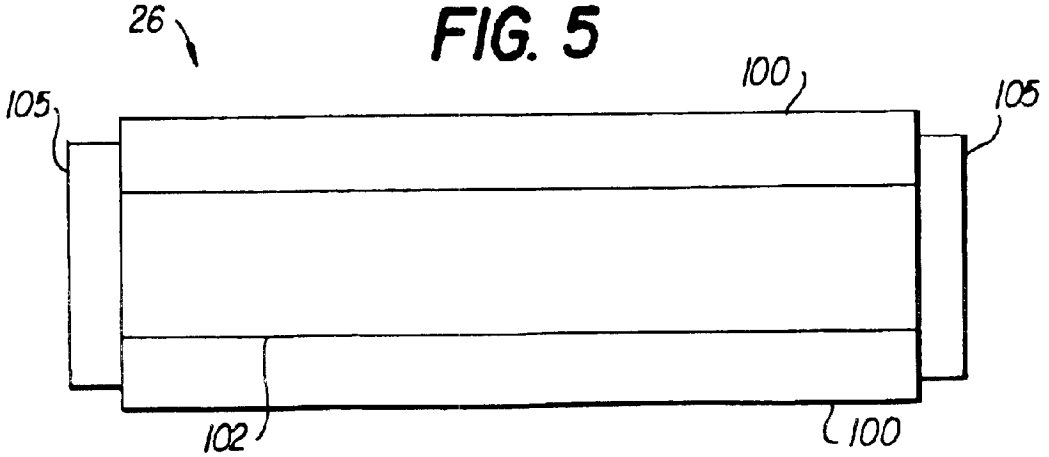


FIG. 4

FIG. 5



CHEMICAL/BIOLOGICAL HELMET

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of personal safety devices including the ability to provide protection in hostile environments. Specifically, the helmet of the invention includes a selectively actuated filter system, wherein the weight or bulk of the system is located at the rear of the wearer's head.

2. Background

Since the advent of chemical and biological weapons during the early part of the twentieth century, various safety devices have been developed to ensure the protection of a user by filtering out harmful materials from the ambient air before being inhaled by the user. These safety devices generally include a mask to be worn over the face of the user and a complex system of hoses, tubes and filters. When protection is necessary, the user dons the device, often including multiple involved steps, learned through extended training.

More recently, such conventional protection devices have been combined with helmets and other impact protection devices. For example, U.S. Pat. No. 5,245,993 and No. 4,266,301, both of which are herein incorporated by reference in their entireties, disclose combinations of helmets with these conventional gas masks.

While newer devices have integrated the filtering systems into the helmets, thus eliminating the need for complex hoses, the often bulky or heavy filtering systems are generally positioned in locations generating unnatural forces affecting the center of gravity and forcing the user to compensate. For example, the filtering system of U.S. Pat. No. 5,533,500, herein incorporated by reference in its entirety, extends from the front of the helmet to the uppermost section, but such a placement nevertheless does not offset the awkward center of gravity.

SUMMARY OF THE INVENTION

In order to mitigate problems related to center of gravity and comfort of a user, the filtering system of the chemical/biological helmet of the invention has been moved to the back section of the helmet. Thus, the weight associated with the filter and/or blower are placed farther to the rear of the helmet, such that the center of gravity is positioned over the shoulders of the user, instead of in front of the user's body. By integrating the filter into the structure of the helmet, the need for a body mounted filter and bulky hoses, as in many conventional systems, is eliminated.

Because much of the facial bulk is removed, the included lens or visor system can be expanded to improve visual field of view. Since the mask and hood are not under the helmet, helmet comfort and sealing of optional ear cups are not degraded. Additionally, helmet displays can be head mounted and worn under the helmet visor for improved protection, compatibility and stability.

The helmet of the invention is modular. In other words, it can be worn with or without chemical/biological protection. The visor can be rotated down to rapidly seal off the interior of the helmet from the environment, and optionally automatically activate any blowers associated with the filters. Chemical/biological filters are embedded into the back of the helmet system, and exhaled air is passed though vents in the front of the helmet. The helmet may additionally contain a neck collar and seal for protection of the face and eyes of the wearer.

The helmet of the invention may also contain other components. For example, optional helmet devices include a nosecup assembly, a communications assembly, impact liners, a suspension assembly and a helmet stabilization device. Additionally, the helmet may include a positive pressure or circulating filter blower system, a heads-up display system (for example, internal to the visor), spectacles, radio, and embedded or modular sensor devices such as image intensifiers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows the helmet of the invention.

FIG. **2** is a cross section of the helmet from front to back along a longitudinal axis of the helmet along the center of FIG. **1**.

FIG. **3** is an exploded view of the helmet.

FIG. **4** is a view of a second embodiment of the invention.

FIG. **5** is a view of a filter cross-section.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows a helmet **10** of the invention. Specifically, helmet **10** has a front section **15**, including a visor **17**, and a rear section **20**. Disposed in rear section **20** is a filter system **25**. Filter system **25** typically includes a filter **26** and an optional blower mechanism **27**. Ambient air is drawn into filter **26** via blower mechanism **27**, if provided, or simply by forces generated by the breathing of a user, where harmful particulates or other materials are removed and clean air is finally passed into the interior of helmet **10**. Exhaled air is forced out of one or more exhalation vents **28**, preferably disposed on the lower area of lower section **15**. Preferably, exhalation vents **28** are equipped with one-way valves to prevent the influx of potentially harmful ambient air.

FIG. **1** in combination with FIG. **2** depicts an optional nosecup assembly **30** connected to exhalation vents **28** via hoses **32**. Nosecup assembly **30** may be provided in helmet **10** to control and channel exhaled air within helmet **10**. Although preferably, nosecup assembly **30** is mounted to the interior of helmet **10**, it may alternatively be affixed to a headsock, to be donned prior to donning helmet **10**. Nosecup assembly **30** keeps moist air from reaching visor **17**, while directing exhaled carbon dioxide to exhalation vents **28**. Typically, nosecup assembly **30** and hoses **32** are constructed of a polymer, such as a silicone elastomer.

FIG. **3** is an exploded view of helmet **10** in a preferred embodiment. Shown below a main structure of helmet **10** is a neck collar **50**, including a neck seal **52** and an outer rim **56**. Neck collar **50** allows for protection of the face and eyes of a user from chemical/biological hazards. Neck collar **50** is typically sized to fit the user and is designed to reduce the contamination level in the face and eye area of the helmet. To aid in donning, neck collar **50** preferably is donned before the rest of helmet **10**. Once helmet **10** is donned, neck collar **50** is clamped or otherwise sealingly fitted to helmet **10**. While outer rim **56** corresponds essentially in size, shape and construction to helmet **10**, neck seal **52** preferably ranges in thickness from about 0.010 inches to about 0.030 inches, depending upon the location on the seal and the selected material. The seal, typically, is made of high strength silicone rubber, but could be formed from any organic rubber with suitable elongation and modulus properties, e.g., elongation of at least 500%.

It is additionally considered within the scope of the invention to provide a face seal. This option provides an

improved unblown protection. Such a face seal option can be used alone or in combination with neck collar **50**.

A combination of an inner shell **70** and outer shell **75** are used to construct helmet **10**. In the rear of inner shell **70** is a filter receiving aperture **72**, into which filter system **25** is positioned. In one embodiment, outer shell **75** is constructed to be worn alone as a single piece, but is preferably constructed to be mated with inner shell **70**. Thus, it is possible to utilize outer shell **75** without inner shell **70**, albeit without the biological/chemical protection provided when inner shell **70**, is mated with outer shell **75**. Thus, the combination of inner shell **70** and outer shell **75**, provides a platform for the other optional headgear, while simultaneously providing chemical/biological protection.

Typically, outer shell **75** houses visor **17**, which is rotateable from a first position to a second position by rotating knobs **55**. In the first position, visor **17** is stored between outer shell **75** and inner shell **70**, such that helmet **10** is unsealed and the interior is exposed to the environment. In order to seal the contents of helmet **10**, visor **17** is simply moved from the first position to the second position, in which the helmet **10** is sealed optionally by a clamping mechanism or an inflatable seal. In one embodiment, when visor **17** is rotated in the second position, blower mechanism **27** is activated (energized). This can be achieved by, for example, having a switch actuated by the physical rotation of visor **17** or knobs **55**, or via a manually actuated switch. Typically, visor **17** is made from a transparent polymer having suitable optical properties, preferably polycarbonate or polyurethane material.

Outer shell **75** can also provide impact protection due to its construction. For example, outer shell **75**, as shown in FIG. **4**, may be formed from an impact resistant material, such as a spectra/graphite composite. While inner shell **70** may be constructed of the same material to further provide impact protection, inner shell **70** may also be made of a lower impact plastic to simplify fabrication and assembly. In order to fit wearers of varying sizes, inner shells **70** of different size may be constructed and designed to be mated with the same universally sized outer shells **75**, in a modular fashion.

In one embodiment, visor **17** is permanently sealed as part of inner shell **70** to prohibit unsealing, i.e., visor **17** is fixed in the downward position shown in FIG. **3**. However, the rotating option provides for rapid transition to the chemical/biological mode that can be performed during operations. Having the ability to rapidly seal off to a chemical/biological protection mode allows a user to be less encumbered prior to entering such an environment. By providing visor **17** with the ability to rotate into an inactive position, the user is freed from carrying a separate device to be assembled and worn only when required.

By storing the visor **17** between inner shell **70** and outer shell **75**, visor **17** is protected from the environment when not in use. This is particularly advantageous when visor **17** actually includes multiple elements, each of which is capable of sealing helmet **17** independently. Each of the elements provides an additional layer of protection, to be used alone or in combination. For example, one element may provide sun light protection, while another protects against lasers. Finally, one or more elements of visor **17** may be incorporated into a heads-up display system, wherein icons or other information are displayed to the user.

Blower mechanism **27**, shown schematically in FIG. **2**, may be used to provide positive pressure within helmet **10**. Optionally, such blowers **27** can be placed either in the rear section, in proximity to the filter assembly **25** to provide a "push through" filter system, or in the upper portion of visor **17** to provide a "pull through" filter system. Other electronic systems, such as spectacles, microphones, speakers and other communication devices such as radios, and heads-up displays, mounted either inside inner shell **70**; and sensors, such as image intensifiers or infrared cameras can also be added to outer shell **75**. By mounting displays under visor **17**, a significant benefit can be realized over existing systems, because they can be made smaller and be better protected from a hostile environment.

In another embodiment, inner shell **70'** can be made to split, as shown in FIG. **4**. This split can optionally be located at any location along helmet **10** to provide additional room when donning and could allow the helmet to flex, which is useful when donning while wearing communications headsets.

FIG. **4** additionally shows a multi-functional helmet liner **80** incorporated into inner shell **70'** to allow air to circulate from filter system **25** in rear section **20** of helmet **10**. It must also be noted that outer shell **75'** may also be equipped with the same inner liner **80**. Liner **80** provides ducting necessary to direct filtered air over visor **17** to prevent fogging. Such ducts can be molded directly into liner **80** and channel ribs can be tailored for helmet impact protection based on the number of ribs, height and liner material. Typically, liner **80** is constructed of a lightweight material, such as polyethylene. However, the density may be varied to enhance material stiffness and impact properties. Alternatively, a standard foam liner can be modified with spacers to facilitate circulation within helmet **10**.

Additionally, helmet **10** may be provided with cushioning means **79**, such as foam padding, molded plastic structures, or simple pieces of fabric, designed to either comfort the user or to reduce forces from impacts. FIG. **3** depicts a preferred embodiment, wherein two cushioning means (i.e., foam padding) are affixed to the interior surface of inner shell **70** with permanent or removable affixing means **78**, such as hook-and-pile fasteners (i.e., VELCRO hook-and-loop fasteners), double sided tape, glue, or screws. Such affixing means **78** may additionally be used to secure nosecup assembly **30** and earcup **40**.

Helmet **10** may be provided with one or more adjustment devices. For example, tabs **90** (FIG. **2**) may be attached to the inside of inner shell **70** to allow attachment of, for example, a chin strap, to secure helmet **10**. Tabs **90** may also be used to tighten ear cups **40** to further aid in helmet stabilization.

Finally, filter assembly **25** is particularly designed to clean any harmful materials from the environment. Filter **26** is also preferably designed to provide low breathing resistances and is also preferably formed from more than one filter medium. The filter media are typically carbon loaded web media **102** (FIG. **5**) for vapor filtration and particulate media **100**, for example, electrostatic media for particulate filtration.

In a preferred embodiment, sorbent layers are made from carbon loaded web. Carbon loading can be accomplished using ground ASZM-TEDA carbon from Calgon Carbon Corporation of Pittsburgh, Pa. This media offers excellent sorbent filtration and low pressure drop characteristics. The media are typically loaded to 300 g/m^2 of carbon and layered to provide the required chemical protection for any operation. Use of four layers is preferred, wherein the typical surface area for the entire filter **26** is approximately 250 cm^2 to 300 cm^2.

The particulate layers are preferably made from an electrostatic media, for example. Particulate filtration media are

included along with the carbon loaded web structure. Preferred is a material that offers excellent aerosol filtration and very low pressure drop characteristics. Typically, the media are optimized to provide near HEPA (high efficiency particulate air) performance at a depth of approximately 0.1 inches, wherein the surface area is 250 cm^2 to 300 cm^2. Such HEPA performance is generally understood to mean retention of all particles as small as 0.3 microns (the typical size of airborne particles such as pollen, dust, mold spores, dust mites, bacteria, and animal or bird dander) with an efficiency rating of 99.97%.

Filter **26** is preferably formed by layering the sorbent structure (e.g., carbon leaded web media **102**) between two layers of particulate media **102**. Edge sealing (by edge seal **105**) can be accomplished either with a thermoplastic edge seal adhesive or a silicone adhesive, as shown in FIG. **5**.

It should be apparent that embodiments other than those specifically described above may come within the spirit and scope of the present invention. Hence, the present invention is not limited by the above description, but rather is defined by the claims appended hereto.

We claim:

1. A modular helmet, comprising:

(a) an outer shell including a visor, said outer shell adapted to function as a standard helmet to protect the head of a wearer; and

(b) an inner shell which can be removably attached to said outer shell, said inner shell comprising a front section and a back section, said back section including a chemical-biological filtration system comprising a chemical-biological filter positioned such that the center-of-gravity of the helmet is positioned over the shoulders of the wearer when the inner shell is attached, and said inner shell further comprising a liner having ducts positioned to direct airflow drawn through said filtration system over said visor, wherein said inner shell can be attached to said outer shell when needed to provide a helmet having chemical-biological protection capability.

2. The helmet of claim **1**, wherein said inner shell further comprises a nose cup assembly and exhaust ports connected to said nose cup assembly.

3. The helmet of claim **2**, wherein said nose cup assembly comprises a nose cup and at least one exhaust hose, wherein said exhaust hose connects said nose cup to said exhaust ports.

4. The helmet of claim **1**, wherein said liner is formed from polyethylene or foam and modified with spacers to provide circulation channels.

5. The helmet of claim **1**, wherein said inner shell further comprises a first part and a second part, such that during donning of said helmet, said first part and said second part are mated to form said inner shell.

6. The helmet of claim **1**, further comprising a neck collar, said neck collar comprising a neck seal formed from rubber, and an outer rim attached to said neck seal, said neck collar being attached or otherwise fitted to said inner shell or said outer shell of said helmet such that an airtight seal is created around the neck of a person donning said helmet.

7. The helmet of claim **1**, further comprising at least one adjustment device to secure said helmet to a wearer, said adjustment device consisting of and ear cups.

8. The helmet of claim **1**, wherein said filtration system is positioned in a recess in said back section of said inner shell.

9. The helmet of claim **1**, wherein said chemical-biological filtration system further comprises and at least one blower positioned to draw external ambient air through said filter and into the interior of said helmet.

10. The helmet of claim **9**, wherein said filter comprises carbon-loaded web media and electrostatic media.

11. The helmet of claim **10**, wherein said carbon loaded web media comprises at least one layer impregnated with carbon, loaded to at least 300 grams of carbon per square meter of media.

12. The helmet of claim **10**, wherein said carbon loaded web media is sandwiched between sections of electrostatic particle media and edge sealed with an adhesive sealant.

13. The helmet of claim **9**, wherein said filter has a total surface area of between about 200 and 350 square centimeters.

14. The helmet of claim **1**, wherein said visor seals the interior of said helmet from the environment.

15. The helmet of claim **1**, wherein said visor is pivotable from a closed position wherein the interior of said helmet is sealed from the environment, to an open position wherein the interior of said helmet is open to the environment.

16. The helmet of claim **15**, wherein when in said open position said visor is stored between said outer shell and said inner shell.

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